Quantization of space-time and Zeno's aporia.

Bezverkhniy Volodymyr Dmytrovych.

Ukraine, e-mail: bezvold@ukr.net

When quantizing space-time, scientists are faced with the same problems that the ancient Greek philosopher Zeno faced 2.5 thousand years ago in his famous aporias [1]. Indeed, there is nothing new under the Moon.

Zeno of Eleisky in the aporia "Flying Arrow" absolutely strictly showed that if there is a quantization of time, then motion is impossible in principle. Here is the formulation of the "Flying Arrow" aporia [2]:

"The flying arrow is motionless, since at every moment of time it occupies an equal position to itself, that is, it is at rest; since it is at rest at every moment of time, then it is at rest at all moments of time, that is, there is no moment in time at which the arrow moves".

It is obvious that Zeno made a time quantization and discovered a paradox, since then movement is impossible; and then, he expressed it in his aporia. It is interesting to note that Aristotle directly points out the impossibility of time quantization, here's a quote [3]:

“The third [argument] just mentioned is that the flying arrow is stationary. [This conclusion] follows from the postulate that time consists of [separate] 'nows': without this assumption, inference is impossible".

Conclusion: you need to teach philosophy. It turns out that modern physics problems have been solved a long time ago, and, moreover, so simply... and brilliantly!

Similarly, in the aporia "Achilles and the Turtle" it is shown that if there is a quantization of space, then no bodies could overcome the distance between themselves. That is, they would not be able to collide, which means there would be no interaction between them. Hence the conclusion: if there is a quantization of space, then interactions between bodies are impossible in principle. No interactions!!! Here is the formulation of the aporia "Achilles and the Turtle" [4]:

"The swift-footed Achilles will never catch up with the leisurely turtle, if at the beginning of the movement the turtle is in front of Achilles.

Let's say Achilles runs ten times faster than a turtle and is a thousand steps behind it. During the time it takes Achilles to run this distance, the turtle will crawl a hundred steps in the same direction. When Achilles has run a hundred steps, the turtle will crawl ten more steps, and so on. The process will continue indefinitely, Achilles will never catch up with the turtle".

I would especially note that if there is a certain distance between the bodies, let's call it “abyss”, and the space is quantized, then this distance (this “abyss”) cannot be overcome in principle. It doesn't matter how small or large this distance is.

In fact, Zeno's aporia "Achilles and the Turtle" strictly leads us to the conclusion that if we can overcome the distances between bodies (this is obvious from our experience), then our space-time continuum must be continuous. Moreover, neither time nor space can be quantized in the usual sense. That is, everything is the same as in A. Einstein's special theory of relativity [5].

After the above, we still ask the question: is time or space quantized?

Answer: Yes, of course ☺! When quantizing space-time, we get elementary particles that are structureless in their essence and exhibit wave-particle properties. It is the wave-particle properties of elementary particles that are the space-time continuum at the quantum level. There is nothing more! This is the limit!

Recall that the de Broglie wave is an interval wave [6]:

"… $ʎ = h / (m*v) \rightarrow S = h / (m*v)$

where S — is interval, $S = L * (1 – v^2/c^2)^{0.5} * c/v$

… $L = \lambda c. / (1 - v^2 / c^2)^{0.5}$

The resulting formula clearly demonstrates that the distance between two points, that is, the de Broglie wavelength, is an increased Compton wavelength. Moreover, it is quite obvious that the increase in the wavelength occurs precisely due to the increase in the duration of the oscillation time.

$$\Delta t = \Delta t0 / (1 - v^2 / c^2)^{0.5}$$

Thus, our space-time continuum is formed according to A. Einstein's STR from the Compton wavelength of a microparticle. At distances smaller than Compton's, it makes no sense to talk about lengths, time, dimensions, etc., since we have a boiling vacuum. Also, an elementary particle has no dimensions, its radius literally tends to zero $r \rightarrow 0$. But, nevertheless, its radius is not equal to zero, since an elementary particle exists in the real material world, and has certain energy characteristics. If its radius were equal to zero, then such a particle would not exist in our Universe.

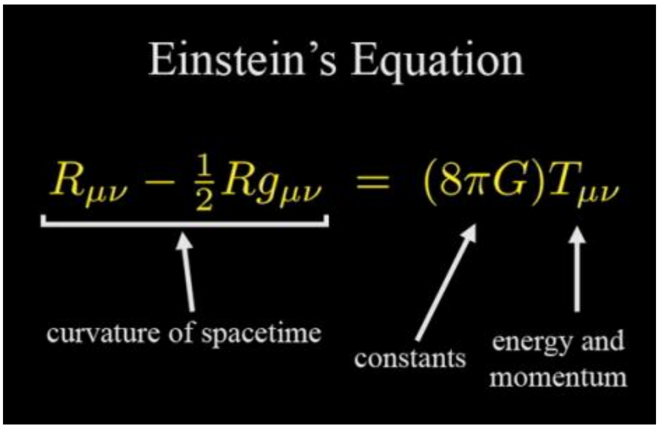
At distances greater than the Compton wavelength of an elementary particle, our space-time continuum is already forming. Moreover, an increase in the Compton length "gives rise" to the length itself, that is, the space itself (x, y, z). And the increase in the oscillation time "gives birth" to our time (t). From the foregoing, it is obvious that time is only just the duration of the oscillation, which we fix in different frames of reference. Therefore, time is a scalar. The time gradient that is formed in space is a simple scalar field that we can observe with our own eyes at a macroscale using the example of the recession of galaxies. Hubble-Lemaitre's law is a direct embodiment of this time gradient...

It is also quite obvious that the space-time continuum is simply an experimental fixation of the spatial and temporal characteristics of oscillations, from a certain frame of reference (according to A. Einstein's STR). Consequently, the space-time continuum does not consist of the material environment. In fact, it does not exist, it is just a kind of mathematical averaging of the process of oscillation of elementary particles".

If we look at the formula of Louis de Broglie written in interval form:

$$S = h / (m * v)$$

It is easy to see that on the left side of the equation we have an interval, that is, our space-time continuum, and on the right side we have the momentum of a particle. In fact, this equation is similar to Einstein's equation, but it is applicable in the quantum world. Compare.



"…Einstein's equation connects the geometric properties of space-time (the left side of the equation) with the dynamics of matter, which creates a gravitational field. The essence of Einstein's equations can be formulated as follows: space-time shows matter how to move, and matter shows space-time how to bend it" [7].

We also recall that the Heisenberg uncertainty principle is derived from the de Broglie interval wave, that is, from the wave-particle dualism, which expresses the fact that in the microcosm our concepts (length, time, etc.) are not fundamental and are relative, so how they depend on the frame of reference [8]. That is, Heisenberg's uncertainty principle is an expression of Einstein's principle of relativity at the quantum level.

P.S. I remembered a comment from one user under a video in which a famous physicist was talking about modern theories:

> “Looked at quantum gravity. I pressed "Pause" and thought for a long time...” ☺.

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